The appropriateness of training exposures for match-play preparation in adolescent schoolboy and academy rugby union players.

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Padraic J. Phibbs[1,2], Ben Jones[1,2], Dale B. Read[1,2], Gregory A.B. Roe[1,2], Joshua Darrall-Jones[1,2], Jonathon J.S. Weakley[1,2], Andrew Rock[3], & Kevin Till[1,2]

[1]Institute for Sport, Physical Activity and Leisure, Leeds Beckett University, Leeds, West Yorkshire, United Kingdom
[2]Yorkshire Carnegie Rugby Club, Headingley Carnegie Stadium, Leeds, West Yorkshire, United Kingdom
[3]Bath Rugby, Farleigh House, Farleigh Hungerford, Bath, United Kingdom

Corresponding Author: Padraic J. Phibbs,
G03 Macauley Hall,
Institute for Sport, Physical Activity and Leisure,
Centre for Sports Performance,
Headingley Campus,
Leeds Beckett University,
West Yorkshire,
LS6 3QS
Phone: +447541731671
Email: p.phibbs@leedsbeckett.ac.uk

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Running Head: Comparison of youth rugby training and match demands

Keywords: Team sport, football, training load, youth.

Abstract

The aim of this study was to compare the physical and movement demands between training and match-play in schoolboy and academy adolescent rugby union (RU) players. Sixty-one adolescent male RU players (mean ± SD; age 17.0 ± 0.7 years) were recruited from four teams representing school and regional academy standards. Players were categorised into four groups based on playing standard and position: schoolboy forwards (n=15), schoolboy backs (n=15), academy forwards (n=16) and academy backs (n=15). Global positioning system and accelerometry measures were obtained from training and match-play to assess within-group differences between conditions. Maximum data were analysed from 79 match files across 8 matches (1.3 ± 0.5 matches per participant) and 152 training files across 15 training sessions (2.5 ± 0.5 training sessions per participant). Schoolboy forwards were underprepared for low-intensity activities experienced during match-play, with schoolboy backs underprepared for all movement demands. Academy forwards were exposed to similar physical demands in training to matches, with academy backs similar to or exceeding values for all measured variables. Schoolboy players were underprepared for many key, position-specific aspects of match-play, which could place them at greater risk of injury and hinder performance, unlike academy players who were better prepared.

Introduction

The aim of a structured sport training programme is to prepare athletes for the demands of competition and to reduce the risk of injury. This is achieved through exposure to training and competition stressors to promote increased physiological and psychological tolerance for future exposures (Smith, 2003). Training demands should expose players to the specific intensity and volume of match-play in the training week (Dawson, Hopkinson, Appleby, Stewart, & Roberts, 2004). However, it is unfeasible for training to reflect the demands of match-play during each and every session, especially in contact team sports like rugby union, because of the associated negative outcomes such as increased fatigue responses and potential injury risk (Dawson, Hopkinson, Appleby, Stewart, & Roberts, 2004; Gabbett, Whyte, Hartwig, Wescombe, & Naughton, 2014). However, there are limited studies that have evaluated the differences between training and competition in adolescent collision team sports (Gabbett & Domrow, 2007; Henderson, Cook, Kidgell, & Gastin, 2015), particularly rugby union (Hartwig, Naughton, & Searl, 2011).

Rugby union is characterised by a combination of intermittent periods of moderate- to high-intensity low-speed (e.g. tackles, rucks, and scrums) and high-speed (e.g. striding and sprinting) activities interspersed with periods of low intensity activities or rest (Quarrie, Hopkins, Anthony, & Gill, 2013). In senior rugby union, it has been suggested that no single training modality (e.g. game-based, skills, traditional endurance, or high-intensity interval training) is sufficient to prepare players for the rigours of match-play, but improved preparation for matches occurs when a combination of activities is used (Tee, Lambert, & Coopoo, 2016). For example, coaches could adopt training modalities to expose players to contact-based activities on one day of the training week and to locomotor (i.e. running-based activities) on another. Therefore, analysis of the mean demands of a training week (Hartwig et al., 2011; Henderson et al., 2015), might reduce exposure to contact or locomotor tasks over the training week because they could have been the focus of individual sessions rather than being a consistent focus throughout the week. The analysis of the maximum training demands offers an alternative perspective on actual exposure of players to specific training physical and movement demands, instead of the mean demands that have been previously examined (Hartwig et al., 2011).

To our knowledge, only one study has compared demands of training to those of match-play in adolescent rugby union players (Hartwig et al., 2011). This study reported mean total distance (2710 ± 770 vs. 4000 ± 500 m) and number of sprints performed (1 vs. 22). Both measures were substantially less in training than match-play. The study was limited by available technology and laws of the game at the time, which prohibited the use of global positioning systems (GPS) during competition. These limitations resulted in the comparison of match demands captured with computer-based tracking with training demands captured by 5 Hz GPS units that could have resulted in inflated error because of low between-system reliability (Cummins, Orr, O'Connor, & West, 2013). The study also grouped participants from various playing standards and age categories together in their analysis. Therefore, the appropriateness of training exposures specific to individual playing standards is unknown, and might differ considerably as a result of different coaching standards.

As the physical demands of junior rugby union training and match-play have increased in recent times (Lombard, Durandt, Masimla, Green, & Lambert, 2015; Phibbs et al., 2017), the demands of adolescent rugby union training need to be revisited. In addition, current literature indicates that there are no differences in the physical and movement demands between playing positions (i.e. forwards and backs) during training (Hartwig et al., 2011), despite players frequently training in position-specific units and the well-established differences in physical and movement demands during adolescent match-play (Deutsch, Maw, Jenkins, & Reaburn, 1998; Portillo, Abián, Navia, Sánchez, & Abian-Vicen, 2014; Venter, Opperman, & Opperman, 2011). The authors of the study acknowledged that their findings could be limited because of the heterogeneous sample used and that a more homogenous sample might offer greater insight (Hartwig et al., 2011). It is unlikely that a one-size-fits-all approach to training adequately prepares players across a range of playing positions for the specific contact demands and movement patterns experienced in match-play (Tee et al., 2016).

As changes in the laws of the game now allow the use of GPS devices during match-play, alongside the advances in technology that have improved the precision and accuracy of GPS units (Varley, Fairweather, & Aughey, 2012), better comparisons of training and match-play using the same time-motion analysis technique can now be made. Therefore, the aim of this study was to compare demands of training and match play, specific to playing standard and position, in adolescent rugby union players. A greater understanding of the specific demands of training and match-play will enable coaches to prescribe training that adequately prepares players for competition and therefore reduce injury risk.

Methods

Participants

Sixty one adolescent male rugby union players (mean ± SD; age 17.0 ± 0.7 years) were recruited for this study representing three U18 schools (i.e. schoolboy; n = 30) and one U18 regional academy (i.e. academy; n = 31) playing standards. Players were categorised into four groups according to playing standard and position: schoolboy forwards (n = 15), schoolboy backs (n = 15), academy forwards (n = 16), and academy backs (n = 15). Table 1 shows the participant characteristics of each group (i.e. age, stature, body mass and maximum sprint speed [MSS]). Ethics approval was granted by the institutional research ethics committee.

INSERT TABLE 1 NEAR HERE

Experimental Design

Time-motion analyses and accelerometry were used to compare physical and movement demands between training and matches. All participants wore the same 10 Hz GPS device (Optimeye S5, Catapult Innovations, Victoria, Australia) during both training sessions and competitive matches during the data collection period. All data were collected mid-season for each respective squad (between October 2014 and January 2015) to control for potential differences in training practices that arise from the stage during a season. Training weeks were described as "typical" (i.e. training frequency and intended intensity) by the coaches who were leading sessions. Training weeks comprised of two evening on-field rugby sessions: one on a Monday, the other on a Thursday for the academy players and three on-field rugby sessions for schoolboy players, with training days differing between respective schools. Each training week was selected to provide a representative microcycle for the respective teams in-season phase, in preparation for a single home competitive fixture.

GPS data were obtained from a total of 79 match files across 8 matches (1.3 ± 0.5 matches per participant) and 152 training files across 15 training sessions (2.5 ± 0.5 training sessions per participant). The mean number of satellites connected was 14.9 ± 0.7 and mean horizontal dilution of precision was 0.69 ± 0.15 during data collection. All participants were required to complete a minimum of a full half of a competitive fixture (i.e. 35 minutes) to be included in the analyses, to limit the influence of pacing strategies associated with substitute players (Black & Gabbett, 2014). Neither training nor match practices were altered or interfered with by the researchers at any time.

Procedures

Before testing, each participant completed an habituation training session wearing the GPS unit. The unit was positioned on the upper back between the scapulae in a tight fitting custom-made vest. The reliability and validity of the devices used in this study have been previously reported (Boyd, Ball, & Aughey, 2013; Gabbett, 2015; Varley et al., 2012). During the session, after a warm up, all participants completed two 40-m maximal sprint efforts to measure MSS. This speed was used to set individualised speed bands for each participant. The MSS value used for each participant in the analyses was taken as the greatest speed measured in the sprint efforts, any training session, or match.

Training and match demands were assessed using GPS and tri-axial accelerometer measures (i.e. distance, PlayerLoad^{TM} [PL], and MSS). Individualised movement demands were classified as low-speed activity (LSA; <61% MSS), high-speed running (HSR; ≥61% MSS) and very-high-speed running (VHSR; ≥90% MSS), as in previous adolescent team sport research (Buchheit, Mendez-villanueva, Simpson, & Bourdon, 2010). The tri-axial accelerometers in the GPS device provided a measure of combined anteroposterior, mediolateral and vertical accelerations to account for additional non-locomotor activity demands of rugby union training (Boyd et al., 2013). Total distance was selected as the global locomotor demand measure and PL for the physical demand, due to their suggested lower within- and between-player variability (McLaren, Weston, Smith, Cramb, & Portas, 2015). Relative measures (i.e. standardised by time) for distance ($m \cdot min^{-1}$), and PL ($PL \cdot min^{-1}$) were used to assess the respective intensities of training and matches. Individualised MSS (%MSS) was recorded to assess peak speeds reached in training and matches relative to a player's maximal sprinting capacity, as well as absolute MSS.

After each training session and match, all GPS and accelerometer data were downloaded to the manufacturer's software (Sprint 5.1.4, Catapult Innovations, Victoria, Australia). Once downloaded, all data were cropped so that only on-field activity for the recorded session time was included.

Statistical Analyses

Maximum data were used from each participant's training and match observations to provide a paired sample for each player to be used in the comparisons. For example, the maximum values for total distance and PL could have come from two different sessions. To compared within-group training and match-play measures, Cohen's *d* effect sizes (*ES*) were used with threshold values set at <0.2 (*trivial*), 0.2-0.59 (*small*), 0.6-1.19 (*moderate*), 1.2-1.99 (*large*) and >2.0 (*very large*) of the pooled standard deviation (Hopkins, Marshall, Batterham, & Hanin, 2009). Uncertainty in each effect was expressed as 90% confidence intervals (CI) and where the 90% CI crossed the negative and positive small ES thresholds (i.e. -0.2 and 0.2) the effect was reported as *unclear*. Between-group comparisons assessed if measures were greater, similar or less than the smallest practical difference (SPD [0.2 x between-player *SD*]) (Hopkins et al., 2009). The probability that differences were greater than the SPD was rated as 25–74.9%, *possibly*; 75–94.9%, *likely*; 95–99.4%, *very likely*; >99.5%, *almost certainly* (Hopkins et al., 2009).

Results

Table 2 presents the mean and SD of the total and relative physical and individualised movement demand differences between training and match-play for schoolboy forwards, schoolboy backs, academy forwards and academy backs. Figure 1 presents the standardised Cohen's *d* effect sizes, 90% confidence intervals, and magnitude-based inferences for within-group differences between training and match-play for all groups.

INSERT TABLE 2 NEAR HERE

INSERT FIGURE 1 NEAR HERE

For the schoolboy forwards group, total PL and LSA were both *likely* greater (*small* ES for PL and LSA, respectively) in matches than training. In the schoolboy backs group, total distance, MSS, LSA, HSR, and relative VHSR were all *likely* greater (*small* ES for LSA, and HSR, respectively, and *moderate* ES for total distance, MSS, and relative VHSR, respectively) in matches than training, with relative MSS and VHSR both *very likely* greater (*moderate* ES for MSS, and VHSR, respectively).

For the academy forwards group, relative PL and relative LSA were both *likely* greater (*small* ES for relative PL, and relative LSA, respectively) in matches than training. However, in the academy backs group, training demands were similar or greater than match demands for all measured variables.

Discussion

The aim of the study was to compare maximum physical and movement demands between training and match-play in adolescent rugby union players, specific to playing standard and position. The main finding of this study was that the academy players were exposed to position-specific physical and movement demands in training similar to or exceeding those experienced in match-play. However, the physical and movement demands of training in the schoolboy players were less position-specific, with many key aspects of training below the demands of competition. These findings suggest that academy players are better prepared for match-play than schoolboy players.

The schoolboy forwards group were prepared for the HSR running demands similar to or exceeding those that are experienced in match-play. However, the schoolboy forwards were substantially underprepared for the physical and low-intensity movement demands, which are key components of match demands for this position. Forwards are more frequently involved in high-intensity activities such as tackles, rucks, mauls, scrums, and lineouts that provide high demands yet have low speed-movement (Deutsch et al., 1998; Quarrie et al., 2013; Roberts, Trewartha, Higgitt, El-Abd, & Stokes, 2008). Hence, participants in the schoolboy forwards group should be exposed to greater static exertion, contact, and low speed activities during training to reduce the position-specific deficit in demands compared to match-play.

In the schoolboy backs group, the players were adequately prepared for the physical demands experienced by their position during matches, but the movement demands were substantially lower in training than matches, especially for VHSR. Speed is an important quality for all rugby players, however, as backs sprint more frequently in match-play and are faster than forwards (Darrall-Jones, Jones, & Till, 2016; Duthie, Pyne, Marsh, & Hooper, 2006), exposure to VHSR should be a greater focus in this positional group. Underpreparing rugby players for absolute and relative peak speeds experienced in competition might not only inhibit speed development but could also place players at an increased risk of injury (Malone, Roe, Doran, Gabbett, & Collins, 2016). Participants in the schoolboy backs group should be exposed to VHSR in training to prepare them for the possibility of reaching near-maximal speeds in match-play (e.g. during a line break).

The academy forwards group were adequately prepared for all physical and movement demands experienced in match-play during training. However, the relative measures of PL and LSA (i.e. indicators of physical and locomotor intensities) were both *likely* lower in training than match-play. Participants in the academy forwards group could be exposed to higher physical and locomotor intensities in training by making small reductions in rest times between drills or efforts, rather than decreasing training volume which would underprepare players for the higher demands experienced in a full 70 minute fixture. This approach would also help to avoid excessive training volumes which have been suggested to be related to both illness and injury risk in adolescent athletes (Gabbett et al., 2014), and therefore should be an important consideration in the design of training sessions.

Although the academy backs were exposed to adequate physical and movement demands that were experienced in matches, the finding that this group (and all other groups in this study) did not regularly exceed speeds greater than 90% MSS during either field-based training or match-play should be a major consideration for practitioners. Previous research also found that the frequency, duration, and distance of sprints were all lower in training than matches in adolescent rugby union players (Hartwig et al., 2011). If athletes are not regularly exposed to speeds above 90% of their maximal capacity it is unlikely that they will improve their maximal sprinting ability, as running at speeds above the VHSR threshold has been suggested to be the most beneficial training method to improve sprint performance (Rumpf, Lockie, Cronin, & Jalilvand, 2015).

As VHSR is classified as the distance covered at very high speed, whether that be absolute or individualised, this metric does not provide information on acceleration sprint efforts that do not cross this threshold. Current technology is bound by the limitations associated with accurately measuring rapid changes in speed that would quantify acceleration sprint efforts (Rampinini et al., 2015; Varley et al., 2012). However, it is evident that coaches should supplement field-based training with maximal sprint training to optimise speed development in adolescent rugby union players. Caution should be taken in the planning of these exposures, as excessive distances at VHSR have been related to injury risk (Gabbett & Ullah, 2012). Coaches should aim to increase VSHR distance by no more than 10% each week to reduce the risk of potential soft-tissue injuries (Gabbett, 2016).

Additionally, the clear differences between the relative speed band measures in this study compared to absolute measures reported in previous adolescent rugby union training studies (Hartwig et al., 2011; Phibbs et al., 2017) illustrates that the previously suggested population-specific absolute speed bands might be too conservative for use with U18 rugby union players, especially in academy populations. Therefore, future research into the movement demands of adolescent rugby union should use similar absolute speed bands as previously reported in adult populations (e.g. 5 $m \cdot s^{-1}$ for HSR and 7.5 $m \cdot s^{-1}$ for VHSR) (Bradley, Cavanagh, Douglas, Donovan, Twist, et al., 2015; Bradley, Cavanagh, Douglas, Donovan, Morton, et al., 2015), which would also allow for direct comparisons between junior and senior rugby union.

Match demands from the current study are comparable to the findings of previous research in adolescent rugby union (Hartwig et al., 2011; Read et al., 2017a; Read et al. 2017b). However, training volumes and intensities are greater in the current study than previously reported (Hartwig, Naughton, & Searl, 2008; Hartwig et al., 2011). These findings support previous research (Lombard et al., 2015; Phibbs et al., 2017) suggesting that the demands of the sport in junior rugby union have increased over the previous decade and that adolescent players are exposed to superior training methods, especially in elite training environments. It is important to note that the analysis of maximum data in the current study can limit comparisons to previous analyses, as the results of this study would be expected to be greater than mean demands. However, the analyses of maximum data allow the comparison of training exposures with the highest match demands, as preparing for mean demands of competition will leave players underprepared for maximum demands. It should also be noted that the use of a single academy and three schools from one region is a limitation of this study, and might not be representative of other regions.

Overall, the disparity in the specificity of training between playing standards might be explained by the differences in understanding of the game and training demands for adolescent rugby union players by their respective coaching and support staff. Unlike for the academy groups, the similar total physical and movement demands of the schoolboy forward and back groups suggests application of a generic training stimulus. Position-specific training, evident in the academy groups in this study, is a superior training strategy in the development of rugby athletes than a one-size-fits-all approach (Duthie, 2006; Smith, 2003; Tee et al., 2016). Although previous research suggests that the demands of training do not differ between forwards and backs in adolescent rugby union (Hartwig et al., 2011), the findings of the present study suggest that training should be both playing standard- and position-specific.

Conclusion

Adolescent rugby players must be prepared for the specific demands of match play required for their respective playing standard and position. The use of maximum data provides an alternative perspective on exposure of players to the demands of training within the training week, as mean data analyses could reduce the magnitude of exposures over multiple observations. Generic training approaches in schoolboy groups might underprepare young rugby union players for key performance variables related to their playing position (e.g. high intensity collision-based demands for forwards and high intensity running-based demands for backs). A more position-specific training approach would improve the appropriateness of training exposures in the schoolboy groups. Field-based training should be supplemented with maximal sprint training to ensure development of maximal speed qualities in young rugby union players, as speeds exceeding 90% MSS are not regularly reached during either field-based training or match-play.

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Figure Captions

Figure 1. Differences between training and match-play physical and individualised movement demands (Cohen's *d* effect sizes, with 90% confidence intervals, and magnitude-based inferences [* Possibly, ** Likely, *** Very Likely, and **** Almost Certainly]) for A) Schoolboy Forwards, B) Schoolboy Backs, C) Academy Forwards, and D) Academy Backs.

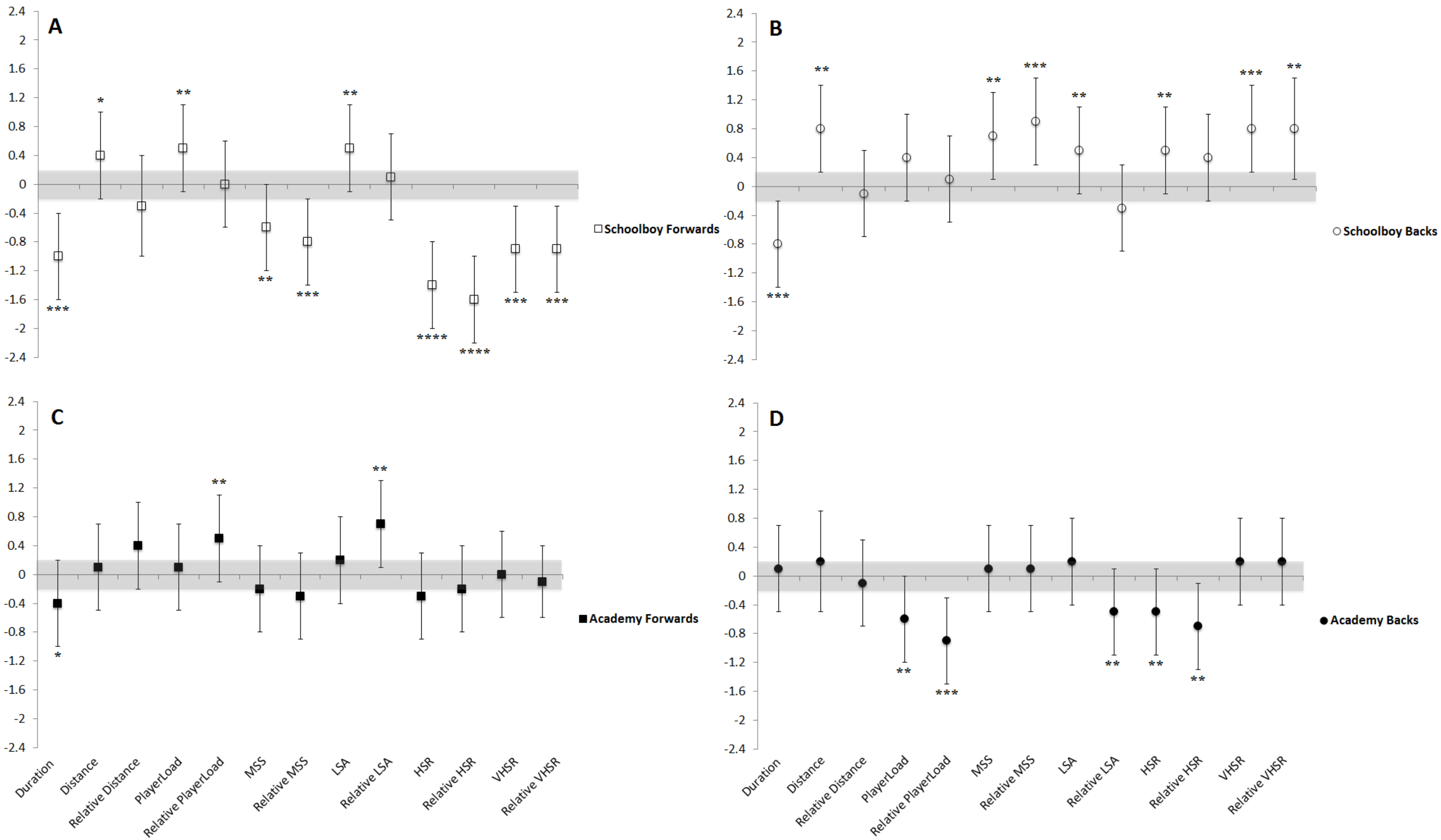
Table 1. Participant Characteristics.

	Schoolboy Forwards (n=15)	**Schoolboy Backs (n=15)**	**Academy Forwards (n=16)**	**Academy Backs (n=15)**
Age (years)	17.3 ± 0.5	17.1 ± 0.7	16.8 ± 0.6	17.0 ± 0.8
Stature (cm)	182.6 ± 6.5	178.2 ± 5.6	187.6 ± 5.4	179.7 ± 5.1
Mass (kg)	89.0 ± 12.2	73.4 ± 7.9	93.8 ± 8.8	81.7 ± 10.0
MSS ($m \cdot s^{-1}$)	8.0 ± 0.5	8.4 ± 0.4	8.2 ± 0.4	8.8 ± 0.4

Data presented as mean ± SD.

Table 2. Training and match physical and individualised movement demands in adolescent rugby union players.

	Schoolboy Forwards (n=15)		Schoolboy Backs (n=15)		Academy Forwards (n=16)		Academy Backs (n=15)	
	Training	Match	Training	Match	Training	Match	Training	Match
Duration (min)	76.7 ± 12.9	61.1 ± 16.9	76.7 ± 12.9	65.5 ± 14.0	68.1 ± 1.4	62.9 ± 17.8	68.3 ± 1.3	69.2 ± 0.2
Total Distance (m)	3433 ± 300	3841 ± 1255	3821 ± 386	4457 ± 1009	4031 ± 755	4128 ± 1232	4678 ± 356	4770 ± 741
Relative Distance (m·min^{-1})	64.2 ± 20.3	58.7 ± 8.1	67.8 ± 7.1	66.9 ± 8.4	62.4 ± 7.8	65.0 ± 5.7	70.3 ± 10.0	69.4 ± 5.5
PlayerLoad (AU)	345 ± 43	399 ± 141	350 ± 48	378 ± 86	407 ± 89	420 ± 130	476 ± 53	431 ± 98
Relative PlayerLoad (AU·min^{-1})	6.4 ± 2.4	6.5 ± 1.3	5.8 ± 0.5	5.8 ± 1.0	6.3 ± 0.9	6.7 ± 0.7	7.2 ± 1.1	6.2 ± 1.0
MSS (m·sec^{-1})	7.1 ± 0.7	6.6 ± 0.9	7.2 ± 0.6	7.6 ± 0.6	7.2 ± 0.6	7.0 ± 0.8	7.8 ± 0.7	7.9 ± 0.6
Relative MSS (%MSS)	89.2 ± 7.1	82.8 ± 8.0	85.8 ± 5.6	90.8 ± 5.8	87.6 ± 6.7	85.3 ± 8.1	88.9 ± 6.3	89.8 ± 6.9
LSA Distance (m)	3238 ± 327	3698 ± 1217	3739 ± 197	4098 ± 918	3719 ± 649	3901 ± 1202	4393 ± 348	4489 ± 720
Relative LSA (m·min^{-1})	58.7 ± 18.0	60.0 ± 11.2	66.2 ± 10.0	62.7 ± 10.2	56.7 ± 7.8	61.8 ± 5.7	69.5 ± 9.9	65.1 ± 6.5
HSR Distance (m)	276 ± 71	138 ± 114	275 ± 105	359 ± 182	252 ± 120	220 ± 111	345 ± 160	280 ± 96
Relative HSR (m·min^{-1})	6.0 ± 2.5	2.3 ± 1.8	4.5 ± 1.7	5.3 ± 2.3	4.2 ± 2.0	3.7 ± 2.1	5.7 ± 3.0	4.0 ± 1.2
VHSR Distance (m)	21 ± 30	0 ± 1	4 ± 9	19 ± 24	5 ± 9	5 ± 10	12 ± 16	15 ± 15
Relative VHSR (m·min^{-1})	0.5 ± 0.8	0.0 ± 0.0	0.1 ± 0.1	0.2 ± 0.3	0.1 ± 0.2	0.1 ± 0.2	0.2 ± 0.2	0.2 ± 0.2


A
B
C
D
Schoolboy Forwards
Schoolboy Backs
Academy Forwards
Academy Backs
Duration
Distance
Relative Distance
PlayerLoad
Relative PlayerLoad
MSS
Relative MSS
LSA
Relative LSA
HSR
Relative HSR
VHSR
Relative VHSR